**Concept Paper for the Proposed NTID Associate of Occupational Studies (AOS) and**

**Associate of Applied Science (AAS) in Biomedical Equipment Technology**

1. **Title/Department/College/Proposer Contact Name and Contact Information**

Biomedical Equipment Technology, Department of Engineering Studies, National Technical Institute for the Deaf

Dino Laury Ed.D., Chairperson, email: [dljnet@rit.edu](mailto:dljnet@rit.edu), videophone: (585) 286-4613

1. **Goals and Justification for the Proposed Program**

The rapid development of clinical engineering and the introduction of increasingly complex and vital biomedical equipment, has created a need for well-prepared technicians in hospitals, medical research centers, and industry. According to the U.S. Bureau of Labor Statistics (BLS), “a significant factor in the greater demand for healthcare services is the aging population. As people age, they usually need more medical care. With the expected increase in the number of older adults and with people living longer, health professionals are prescribing more medical tests that use new, complex equipment.” [1]

While there is a greater demand for health care services, there are limited opportunities for qualified deaf and hard-of-hearing individuals to pursue careers in support of the healthcare industry. As reported in the Executive Summary of the Final Report of NTID’s Task Force on Health Care Careers for the Deaf and Hard of Hearing Community, “generally, d/hh workers are underrepresented in those healthcare occupations requiring higher degrees and overrepresented in those occupations requiring less education.” [2] The vision of the Task Force was to “ensure that d/hh individuals have expanded career opportunities in the healthcare field.”

According to the BLS, employment of medical equipment repairers (Biomedical Equipment Technicians, “BET”), is projected to grow 6 percent from 2014 to 2024, aboutas fast as the average for all occupations(7%). Greater demand for healthcare services and the use of increasingly complex medical equipment will drive employment growth. Those who have an associate-level degree in biomedical equipment technology or engineering should have the best job opportunities. According to the BLS, the median annual wage in 2015 was $46,340 with employment in hospitals, medical research centers, medical equipment manufacturers, electronic repair and maintenance shops, and health and personal care stores. Some workers in this field, about 15%, are self-employed. [1]

From shadowing experiences in Highland Hospital in 2013, interviews with clinical directors in several states, and meetings with education and industry experts in 2013-2015, there is demand for the development of a program to prepare biomedical equipment technicians. According to these experts, there is considerable demand for technicians who know how to repair, maintain, and calibrate equipment such as infusion pumps, electrocardiogram machines, networked patient-monitoring equipment, defibrillators, breathing and respirator equipment, and anesthesia machines. Certification, although beneficial for long-term advancement, is not mandatory for employment.

Therefore, the goals of this proposed program will be to produce graduates who:

1. Demonstrate excellence in theoretical as well as practical knowledge of the principles of biomedical equipment technology.
2. Demonstrate excellent troubleshooting and repair skills
3. Work safely in a healthcare environment
4. Work within teams and with other people
5. **Description of the New Program**

The rapid development of vital and increasingly complex biomedical equipment technology has created a need for well-prepared technicians in hospitals, medical research centers, and industry. Technicians must understand electro-mechanical technology and be capable of maintaining, calibrating, and repairing such equipment. NTID’s proposed Biomedical Equipment Technology associate degree program will prepare students with these essential skills for this career:

* Assemble, maintain, calibrate and repair various pieces of medical equipment/instrumentation
* Test functionality of equipment and take accuracy, sensitivity, and selectivity measurements
* Assist medical staff in operation of equipment
* Follow record keeping protocol for the maintenance and repair of equipment and instrumentation
* Read technical manuals
* Manage replacement of medical equipment

**The Curriculum**

The five-semester curriculum required to earn an associate-level degree in Biomedical Equipment Technology combines general education courses with in-depth technical training and hands-on experiences. Areas of study in this program include:

* Equipment maintenance, troubleshooting and repair
* Basic electromechanical systems
* Healthcare facility safety
* Computer networking
* Human anatomy and physiology

In developing this program, the curriculum development team reviewed standards developed by the Association for the Advancement of Medical Instrumentation (AAMI) to assure that the proposed program is relevant and aligns with the curriculum interests of the medical instrumentation field.

For the AOS degree, there is a total of 64 credits with 42 technical credits; 15 credits in science, math and liberal studies coursework; 6 technical elective credits, one credit for a Freshman Seminar course. There is one zero-credit co-operative work experience that will typically be completed between the fourth and fifth semesters. Students in this AOS degree program will take their mathematics, science, English and general education courses within NTID.

For the AAS degree, there is a total of 73 credits with 42 technical credits; 24 credits in liberal arts, science and math coursework; 6 technical elective credits; and 1 credit for a Freshman Seminar course. There is one required zero-credit co-op typically completed between the fourth and fifth semesters. Students in the AAS degree program typically complete their mathematics and science courses at NTID, but will take English and liberal arts perspectives coursework in the College of Liberal Arts.

Suggested semester-by-semester curriculum masks are provided in Appendix A (AOS) and Appendix B (AAS).

1. **New Programs Fit with RIT Academic Portfolio Blueprint Characteristics and Criteria**

**Characteristics:**

**Innovative Teaching and Learning:** Much of the instruction in this program will be interactive and will include the use of new biomedical equipment equipped with solutions allowing for universal access.

**Experiential Learning:** Students will be required to take a Biomedical Equipment Capstone course in the fourth semester during which time they will work with an employer partner and a faculty mentor. Additionally, between the fourth and fifth semesters, students will be required to complete one co-op work experience to enhance and apply their skills before they graduate.

**Synergy and Interdisciplinary:** Students will benefit from taking different courses from different NTID departments (Information and Computing Studies; Engineering Studies; and Science and Mathematics).

**Inclusive Excellence:** NTID students will be preparing for careers in a field where no NTID associate-level degree programs currently lead. Also, students from the AAS program will take general education coursework in other colleges of RIT, thus adding to the diversity of student experiences in those classes.

**Criteria:**

**Centrality:** The creation of this program is a direct result of the strategic alliance between RIT and Rochester Regional Health System (RRHS) to leverage our combined knowledge and resources to open another channel for deaf and hard-of-hearing individuals to work in support of the healthcare industry. [3]

**Marketability:** Based on BLS projection the employment of medical equipment technician is projected to grow 6 percent in the next 10 years. Greater demand for healthcare services and the use of increasingly medical equipment will drive employment growth. [4] In a letter from Scott Hooker, Director of the NTID Admissions Department, he says “I have read the proposal and description of the program, and agree that the creation of such a program is an excellent idea, and one that is very beneficial for us to implement.”

**Quality:** Faculty trained in electromechanical engineering, computer networking, and health sciences will incorporate rigorous academic and career preparation by working closely with industry experts and partners. An advisory board of industry experts in biomedical equipment will provide guidance and recommendations to the program. Capstone and co-operative work experiences will provide opportunities for experiential learning.

**Financial Viability:** Based on NTID cost model analysis, it is viable to establish the biomedical equipment program as shown in section VIII of this concept paper.

1. **Synergy with Other Programs**

This program will involve studies in several programs and as such, faculty expertise from each of the departments (the Department of Engineering Studies, Information and Computing Studies and the Department of Science and Mathematics) will be needed to teach technical courses. Additionally, faculty from the NTID’s Department of Liberal Studies and from the College of Liberal Arts will teach English and general education/perspectives courses. This will provide well-rounded and capable students.

The AOS and AAS programs are terminal degree programs although students who complete the AAS degree will have the option to design a baccalaureate-level degree through the School of Individualized Study (SOIS). As with existing articulation agreements between NTID and SOIS programs, the BET technical courses can serve as one of the focus areas in the BS degree. Liberal arts, English, science, and math courses taken toward the AAS degree can also satisfy the LAS perspectives, English, and general and free electives requirements of the BS program.

1. **Administrative Structure for the New Program**

The administrative structure of the proposed program will follow the standard departmental administrative structure of NTID degree programs. The program Chair will appoint a program Coordinator and work with the Coordinator as needed relative to administrative duties such as course scheduling, faculty assignments, program budget, and outcomes assessment.

1. **Enrollment Management Expectations and Sustainment**

This program is expected to be popular and will be open to students at the AOS and AAS levels. Proposed enrollment figures are provided in Appendix C. Starting with an enrollment cap of 8 students the first year, we will increase that number to 10 in the third year and 12 incoming students the fifth year and thereafter if anticipated demand materializes. Although new students could conceivably be admitted to the program in the spring, they would have to take English, liberal arts, math, and/or science coursework during this term and then start the first-year technical courses in the following fall semester. Students accepted into this program will be screened to meet the enrollment criteria of the typical AOS and AAS degrees, namely that they must meet specific ACT criteria or have scored at specified levels on the math and English placement tests administered by NTID. These enrollment projections were approved by Scott Hooker, Director of NTID Admissions and Dr. James Miller, RIT Vice President of Enrollment Management and Career Services.

As part of the proposed NTID BET (AOS & AAS) degree programs, expected graduation rates were developed by Rich Dirmyer, NTID Director Institutional Research & Assessment, considering NTID AOS and NTID AAS program students. Expected graduation rates for the first five cohorts of incoming students in the BET programs is projected to be 50% with a persistence rate at 80% from year 1 to year 2, an assumption based on the NTID 2016-2017 Academic Program Analysis rates for the current Engineering Studies programs.

**Impact on Resources**

With the student enrollment and retention rate projected, the teaching load for the technical courses (NBET-XXX) in the first year of the program will require 0.77 FTE (two of five course sections per semester taught by a tenure-track faculty member and three of five by a lecturer) and it should be noted that significant curriculum development will be required of program faculty during the first three years of the program. For the second year the program is in operation, in addition to the five sections of first-year technical courses (0.77 FTE), a total of eight sections of the second-year technical courses (1.22 FTE) will be offered, requiring 1.99 FTE. In the program’s third year and beyond, an additional 0.62 FTE required to instruct the four sections of the third-year courses (two taught by a lecturer and two by a tenure-track faculty member), bringing the total program faculty needs to 2.61 FTE. As for the general education and supporting coursework, based on preliminary discussions with the Chairpersons of the NTID Departments of Liberal Studies and Science & Mathematics, an additional 0.75 FTE will be needed to accommodate these students in liberal arts courses and 0.50 FTE will be needed for math and science courses. The total program FTE need for technical and non-technical courses when fully implemented with therefore be 3.86 FTE, which is not covered by existing headcount.

Start-up costs of approximately $240,000 are anticipated to purchase the following equipment:

* Combined EKG and spirometry function machines $3,500 ea. (new) x seven workstations = $24,500.
* Defibrillators (AED) units pacer and monitor $10,000 ea. (new) x seven workstations = $70,000.
* Infusion pumps, $3000 ea. (new) x seven workstations = $21,000.
* Vital Sign Monitors, $2800 ea. (new) x seven workstations = $19,600.
* Bedside monitor (similar to a Vital Sign Monitor), $6,000 ea. (new) x seven workstations = $42,000.
* Electronics testing equipment, tools, meters, etc. $3,000 (new) x seven workstations = $21,000.
* 26 laptops, two printers and networking (switches/router) equipment = $40,000

Existing classrooms within LBJ will be used to offer this program but some renovation of the space may be required.

## Cost Model Analysis

The NTID cost model analysis, which will be forwarded to the Provost, includes five tables each for the AAS and AOS programs detailing projected expenditures and revenue over the first five years of the programs.  Assuming a 50/50 split of student enrollment between the AAS and AOS programs, faculty/staff salary and benefits plus costs such as computer charges, travel/conferences, tuition payment for RIT credits, and RIT overhead costs total approximately **$2,008,800**.  These costs are expected to be offset by more than **$2,034,000**.  Total revenue minus expense over the five years is estimated to be approximately **$25,200.**  In addition, it is projected that **$240,000** in equipment costs will be required for the establishment of the AAS/AOS program.  [Note that NTID’s tuition is applied to support all academic and non-academic programs accessed by students and the program does not fit into the Net Tuition Revenue Model used by other RIT colleges.  Tuition is subsidized by Federal appropriations and is therefore not cost related]. The amounts used above were calculated by averaging the five year amounts for the AAS and AOS program.

1. **Conclusion**

In summary, the new BET AOS and AAS degree programs will allow NTID to provide technical training in an area that supports the rapidly expanding field of biomedicine. This program will provide unique technical education opportunities for our students and subsequent employment opportunities for our graduates.

This concept paper was developed by a committee of faculty members from the NTID Departments of Engineering Studies; Information and Computing Studies; and Science and Mathematics. It was then reviewed and approved by the full faculty membership of these three departments.

1. **Summary of Community Input and Response to Input**
2. **References**

**[1]** <http://www.bls.gov/ooh/installation-maintenance-and-repair/medical-equipment-repairers.htm#tab-6>

**[2]** <https://www.rit.edu/ntid/hccd/system/files/FINAL_REPORT_Building_Pathways_March_2012.pdf>

**[3]** <https://www.rit.edu/ntid/hccd/system/files/FINAL_REPORT_Building_Pathways_March_2012.pdf>

**[4]** <http://www.bls.gov/ooh/installation-maintenance-and-repair/medical-equipment-repairers.htm>)

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| **Fall Semester (1st year)**   |  |  |  | | --- | --- | --- | | **Course #** | **Title** | **Credits** | | NCAR-100 | Freshman Seminar | 1 | | NENG-212 | NTID LAS Foundation  Career English I | 3 | | NBET-XXX | Shop Skills for Biomedical Equipment Technicians | 3 | | NBET-XXX | Electric Circuits I | 3 | | NMTH-140 or above | NTID LAS Foundation Mathematics | 3 | |  | Total Semester Credit Hours | 13 | | **Spring Semester (1st year)**   |  |  |  | | --- | --- | --- | | **Course #** | **Title** | **Credits** | | NBET-XXX | Safety and Etiquette in Health Care Facilities | 3 | | NENG-213 | NTID LAS Foundation  Career English II | 3 | | NBET-XXX | Sensors and Transducers | 3 | | NBET-XXX | Electric Circuits II | 3 | |  | Total Semester Credit Hours | 12 | |
| **Fall Semester (2nd year)**   |  |  |  | | --- | --- | --- | | **Course #** | **Title** | **Credits** | | NACT-160 | Networking Essentials | 3 | | NBET-XXX | Biomedical Equipment I | 3 | | NBET-XXX | Biomedical Clinical Instrumentation | 3 | | NACT-240 | World of Work | 3 | |  | Total Semester Credit Hours | 12 | | **Spring Semester (2nd year)**   |  |  |  | | --- | --- | --- | | **Course #** | **Title** | **Credits** | | NBET-XXX | Biomedical Equipment II | 3 | | NBET-XXX | Networked Patient Monitoring Devices | 3 | | NSCI-120 or above | NTID LAS- Perspective -Scientific Processes | 3 | | NBET-XXX | Biomedical Equipment Tech Capstone | 3 | |  | Wellness Education | 0 | |  | Total Semester Credit Hours | 12 | |
| **Summer Term (2nd year)**   |  |  |  | | --- | --- | --- | | **Course #** | **Title** | **Credits** | | NBET-299 | Co-op | 0 | |  | Total Semester Credit Hours | 0 | |  |
| **Fall Semester (3rd year)**   |  |  |  | | --- | --- | --- | | **Course #** | **Title** | **Credits** | | NBET-XXX | Biomedical Equipment III | 3 | | NBET-XXX | Medical Device Troubleshooting | 3 | |  | Technical Elective | 3 | |  | Technical Elective | 3 | |  | NTID LAS Perspective | 3 | |  | Total Semester Credit Hours | 15 | | **Note:** NBET is **N**TID **B**iomedical **E**quipment **T**echnology  Courses with XXX numbers are new. |

**Appendix A. Proposed Biomedical Equipment Technology AOS Curriculum**

**Appendix B. Proposed Biomedical Equipment Technology AAS Curriculum**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| **Fall Semester (1st year)**   |  |  |  | | --- | --- | --- | | **Course #** | **Title** | **Credits** | | NCAR-100 | Freshman Seminar | 1 | | LAS Elective | LAS Elective (e.g. UWRT-100) | 3 | | NBET-XXX | Shop Skills for Biomedical Equipment Technicians | 3 | | NBET-XXX | Electric Circuits I | 3 | | NMTH-140 or above | LAS Elective- Mathematics | 3 | |  | Total Semester Credit Hours | 13 | | **Spring Semester (1st year)**   |  |  |  | | --- | --- | --- | | **Course #** | **Title** | **Credits** | | UWRT-150 | First Year Writing: Writing Seminar | 3 | | NBET-XXX | Safety and Etiquette in Health Care Facilities | 3 | | NBET-XXX | Sensors and Transducers | 3 | | NBET-XXX | Electric Circuits II | 3 | | LAS-P4 | LAS Perspective 4 – Social | 3 | |  | Total Semester Credit Hours | 15 | |
| **Fall Semester (2nd year)**   |  |  |  | | --- | --- | --- | | **Course #** | **Title** | **Credits** | | NACT-160 | Networking Essentials | 3 | | NBET-XXX | Biomedical Equipment I | 3 | | NBET-XXX | Biomedical Clinical Instrumentation | 3 | | NACT-240 | World of Work | 3 | | LAS-P2 | LAS Perspective 2 - Artistic | 3 | |  | Total Semester Credit Hours | 15 | | **Spring Semester (2nd year)**   |  |  |  | | --- | --- | --- | | **Course #** | **Title** | **Credits** | | NBET-XXX | Biomedical Equipment II | 3 | | NBET-XXX | Networked Patient Monitoring Devices | 3 | | NSCI-283 | LAS Perspective 6 -Developmental Human Anatomy and Physiology | 3 | | LAS-P3 | LAS Perspective 3 - Global | 3 | | NBET-XXX | Biomedical Equipment Tech Capstone | 3 | |  | Wellness Education | 0 | |  | Total Semester Credit Hours | 15 | |
| **Summer Term (2nd year)**   |  |  |  | | --- | --- | --- | | **Course #** | **Title** | **Credits** | | NBET-299 | Co-op | 0 | |  | Total Semester Credit Hours | 0 | |  |
| **Fall Semester (3rd year)**   |  |  |  | | --- | --- | --- | | **Course #** | **Title** | **Credits** | | NBET-XXX | Biomedical Equipment III | 3 | | NBET-XXX | Medical Device Troubleshooting | 3 | |  | Technical Elective | 3 | |  | Technical Elective | 3 | | LAS-P1 | LAS Perspective 1 - Ethical | 3 | |  | Total Semester Credit Hours | 15 | | **Note:** NBET is **N**TID **B**iomedical **E**quipment **T**echnology  Courses with XXX numbers are new |

**Appendix C. Biomedical Equipment Technology AOS/AAS Program Enrollment Projections**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Enrollment Due to New Students | | | | Enrollment Due to Persisting Students | | | **Total Enrollment** |
| Term (Year) | Internal Transfer | Would come to NTID without program | New to NTID because of program | **Total** | From Two Years Prior | From One  Year Prior | **Total** |
| Fall (1) | 2 | 2 | 4 | **8** | - | - | **-** | **8** |
| Spring (1) | 2 | 2 | 4 | **8** | - | - | **-** | **8** |
| Fall (2) | 1 | 2 | 5 | **8** | - | 7 | **7** | **15** |
| Spring (2) | 1 | 2 | 5 | **8** | - | 7 | **7** | **15** |
| Fall (3) | 1 | 2 | 7 | **10** | 7 | 7 | **14** | **24** |
| Spring (3) | 1 | 2 | 7 | **10** | - | 7 | **7** | **17** |
| Fall (4) | 1 | 2 | 7 | **10** | 7 | 8 | **15** | **25** |
| Spring (4) | 1 | 2 | 7 | **10** | - | 8 | **8** | **18** |
| Fall (5) | 1 | 3 | 8 | **12** | 8 | 8 | **16** | **28** |
| Spring (5) | 1 | 3 | 8 | **12** | - | 8 | **8** | **20** |